

WHAT IS CLAIMED IS:

- 1 1. An electrosurgical instrument for delivering energy to tissue,
2 comprising:
3 a working end for engaging the tissue;
4 a surface layer at an exterior portion of the working end, the surface layer
5 comprising a matrix of polymeric PTC composition adapted to deliver electrical current to
6 the tissue; and
7 a cooling structure at an interior portion of the working end;
8 wherein the cooling structure cools the PTC matrix to lower the temperature of
9 one or more portions of the PTC matrix.
- 1 2. The electrosurgical instrument of claim 1, wherein the PTC matrix
2 defines a switching range at which the electrical resistance substantially increases in a
3 selected temperature range.
- 1 3. The electrosurgical instrument of claim 2, wherein the surface layer
2 has a thickness of less than about 500 microns.
- 1 4. The electrosurgical instrument of claim 3, wherein the surface layer
2 has a thickness ranging between about 0.1 microns and 200 microns.
- 1 5. The electrosurgical instrument of claim 4, wherein the surface layer
2 has a thickness ranging between about 0.5 microns and 100 microns.
- 1 6. The electrosurgical instrument of claim 1, wherein the cooling
2 structure passively cools the PTC matrix.
- 1 7. The electrosurgical instrument of claim 6, wherein the cooling
2 structure comprises a thermally conductive material forming an electrode which conducts
3 electrical current from a power source to the PTC matrix.
- 1 8. The electrosurgical instrument of claim 7, wherein the cross-section of
2 the conductive portion is significantly larger than the PTC surface layer.

1 9. The electrosurgical instrument of claim 7, wherein the cooling
2 structure comprises a material selected from a group consisting of copper-beryllium alloy,
3 copper, aluminum, silver, or gold.

1 10. The electrosurgical instrument of claim 7, further comprising a ground
2 electrode, and wherein the power is supplied to the thermally conductive electrode in a mono-
3 polar configuration.

1 11. The electrosurgical instrument of claim 1, wherein the cooling
2 structure actively cools the PTC matrix.

1 12. The electrosurgical instrument of claim 11, wherein the cooling
2 structure communicates with a fluid-cooling circulation system.

1 13. The electrosurgical instrument of claim 12, further comprising a fluid
2 source, wherein the cooling structure has a flow channel to form a flow loop through which
3 the fluid source circulates a fluid.

1 14. The electrosurgical instrument of claim 13, further comprising a heat
2 exchanger, wherein the fluid pump circulates the fluid through the heat exchanger.

1 15. The electrosurgical instrument of claim 13, wherein the fluid
2 comprises water.

1 16. The electrosurgical instrument of claim 13, wherein the fluid
2 comprises a cooling gas.

1 17. The electrosurgical instrument of claim 16, wherein the cooling gas
2 comprises a cryogen selected from the group consisting of freon or CO₂.

1 18. The electrosurgical instrument of claim 17, further comprising an
2 expansion chamber, wherein the cooling gas absorbs heat as it changes its phase state while
3 in the expansion chamber.

1 19. The electrosurgical instrument of claim 18, further comprising an
2 inflow channel and outflow channel for circulating the gas between the fluid pump and the
3 expansion chamber.

1 20. The electrosurgical instrument of claim 1, wherein the cooling
2 structure comprises a Peltier element.

1 21. The electrosurgical instrument of any of claims 6 or 11, wherein the
2 surface layer defines an engagement surface for engaging tissue.

1 22. The electrosurgical instrument of claim 21, wherein the engagement
2 surface is carried on the working end of a probe.

1 23. The electrosurgical instrument of claim 21, wherein the engagement
2 surface is carried on the working end of a jaw structure, the jaw structure comprising paired
3 first and second jaws moveable between an open position and a closed position.

1 24. The electrosurgical instrument of claim 23, wherein at least one jaw
2 defines an engagement plane, the engagement plane carrying at least a portion of the
3 engagement surface.

1 25. The electrosurgical instrument of claim 24, wherein the wherein the
2 cooling structure comprises a thermally conductive material forming an electrode which
3 conducts electrical current from a power source to the PTC matrix.

1 26. The electrosurgical instrument of claim 25, wherein a plurality of
2 electrodes are formed on the jaw structure, and wherein power is delivered to the electrodes
3 in a bipolar configuration.

1 27. A method of controlled delivery of energy to tissue, comprising the
2 steps of:

3 engaging tissue with an engagement surface at least a portion of which
4 comprises a body of temperature-responsive variable impedance material that is intermediate
5 opposing polarity conductor regions operatively coupled to an RF power source;

6 delivering current flow within the engaged tissue and the engagement surface
7 to cause ohmic heating of the tissue, wherein the ohmically heated tissue conductively heats
8 adjacent regions of the engagement surface, and wherein the engagement surface varies its
9 impedance to modulate current flow between the engagement surface and the tissue; and

10 contemporaneously cooling the variable impedance body to thereby accelerate
11 modulation of current flow between the engagement surface and the engaged tissue.

1 28. The method of claim 27, wherein cooling the variable impedance body
2 comprises passively cooling the engagement surface.

1 29. The method of claim 28, wherein passively cooling the variable
2 impedance body comprises providing a cooling structure at an interior of the working end,
3 wherein the cooling structure comprises a thermally conductive material.

1 30. The method of claim 28, wherein the cooling structure comprises an
2 electrically conductive material forming an electrode, and wherein delivering current flow
3 comprises delivering RF energy to the engagement surface via the electrically conductive
4 material.

1 31. The method of claim 27, wherein cooling the variable impedance body
2 comprises actively cooling the engagement surface.

1 32. The method of claim 31, wherein actively cooling the variable
2 impedance body comprises cooling the engagement surface via a fluid-cooling circulation
3 system.

1 33. The method of claim 32, wherein cooling the variable impedance body
2 comprises circulating a fluid through a flow channel proximal to the engagement surface.

1 34. The method of claim 33, wherein cooling the variable impedance body
2 further comprises circulating the fluid through a heat exchanger.

1 35. The method of claim 33, wherein the fluid comprises water.

1 36. The method of claim 33, wherein the fluid comprises a cooling gas.

1 37. The method of claim 36, wherein the cooling gas comprises a cryogen
2 selected from the group consisting of freon or CO₂.

1 38. An electrosurgical instrument for delivering energy to tissue,
2 comprising:
3 an introducer member having at least one working surface for engaging tissue,
4 wherein at least a portion of the at least one working surface comprises a polymeric PTC
5 composition; and

6 a conductor at an interior of the PTC composition, the conductor having at
7 least one open region at an interior of the conductor for cooling the assembly of the conductor
8 and PTC composition.

1 39. The electrosurgical instrument of claim 38, wherein the conductor
2 comprises an electrically conductive material forming an electrode, the electrode connected
3 to a radiofrequency power source to ohmically heat the tissue.

1 40. The electrosurgical instrument of claim 39, wherein the conductive
2 material is also thermally conductive to act as a heat sink.

1 41. The electrosurgical instrument of claim 38, wherein the open region
2 communicates with a fluid-cooling circulation device.

1 42. The electrosurgical instrument of claim 41, wherein the fluid cooling
2 circulation device comprises a fluid source for providing fluid flow through the at least one
3 open region.

1 43. The electrosurgical instrument of claim 42, wherein the fluid source
2 communicates with a heat exchange structure.

1 44. The electrosurgical instrument of claim 43, wherein the fluid
2 comprises water.

1 45. The electrosurgical instrument of claim 41, wherein the fluid
2 comprises a cooling gas.

1 46. The electrosurgical instrument of claim 45, wherein the cooling gas
2 comprises a cryogen selected from the group consisting of freon or CO₂.

1 47. The electrosurgical instrument of claim 40, wherein the working
2 surface defines an engagement surface for engaging tissue.

1 48. The electrosurgical instrument of claim 47, wherein the engagement
2 surface is carried on the working end of a probe.

1 49. The electrosurgical instrument of claim 47, wherein the engagement
2 surface is carried on the working end of a jaw structure, the jaw structure comprising paired
3 first and second jaws moveable between an open position and a closed position.

1 50. The electrosurgical instrument of claim 49, wherein at least one jaw
2 defines an engagement plane, the engagement plane carrying at least a portion of the
3 engagement surface.